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Natural Falling of Beetle-Killed Ponderosa Pine

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Beetle-killed trees in the Front Range of Colorado were observed for their rate and direction of falling. No trees fell within the 2 years following infestation. Thereafter, trees generally fell at the rate of 3–5% per year unless winds exceeded 75 mph. Most trees fell to the east and broke off between ground level and 2 feet above ground.

Keywords: *Dendroctonus ponderosae* Hopkins, *Pinus ponderosa* Lawson

Management Implications

Forest managers need not be concerned with the falling of beetle-killed ponderosa pine until more than 3 years after infestation. Thereafter, strong winds will blow down many trees when winds exceed 75 mph.

Introduction

Infestations of the mountain pine beetle (MPB), *Dendroctonus ponderosae* Hopkins, leave varying numbers of dead trees in unmanaged stands of ponderosa pine, *Pinus ponderosa* Lawson. These trees stand for varying periods of time, becoming both a benefit and a liability for forest managers. Initially, the dead needles and twigs create high fire hazard (Brown and Davis 1973). At the same time, dead trees provide food and nesting sites for birds. As time progresses, fire hazard from needles and twigs decreases; but the hazard of falling trees increases for recreationists (Environment Canada 1982). Beetle-killed trees are also highly suitable for firewood in the years immediately after infestation; but their suitability decreases as the wood decays, and generally ends once the trees have fallen. To reduce hazards and increase utilization, forest managers need to know the rate beetle-killed trees fall and what characteristics can be used to estimate when and where trees fall. This note reports on a 10-year study of the natural falling of beetle-killed trees in the Front Range of Colorado.

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Methods

In August 1973, 105 trees killed by the MPB on the Arapaho and Roosevelt National Forest in 1972, were selected and tagged for further observations. Fifty trees were east of Red Feather Lakes, Colorado in Section 7, T9N, R72W (Log Cabin), and 55 trees were north of Red Feather Lakes in Section 16, T10N, R73W (Section 16). Tree diameters ranged from 7 to 22 inches d.b.h. and 7 to 18 inches d.b.h. at both locations, respectively. Each tree was examined annually thereafter, at which time the tree was classified as standing or fallen. If fallen, the distance from ground level to point of breakage was measured, and the portion of the bole at the breaking point was examined for contributing agents such as insects and decay fungi. As the study progressed, woodcutters removed trees for firewood despite signs warning otherwise. As of September 1982, 21 trees had been cut and, therefore, were deleted from the original number; as a result, only 84 were available for the 10 years.

By 1976 it became apparent that insect and fungal activity in the basal portion of the bole were influencing where trees broke off. To determine if an insecticide application to the first 6 feet of bole would prevent the attacks of secondary insects and thus retard deterioration, 30 pairs of newly attacked trees were selected near Arthur's Rock (Section 13, T7N, R70W) west of Fort Collins, Colo. Tree diameters ranged from 6 to 16 inches; but trees of similar size were paired. One of each pair was sprayed with a 2% lindane and oil solution after at-

tack by MPB but before most secondary insect infestation. All trees were inspected annually in August. Information on standing or fallen, point of breakage if fallen and the presence or absence of insects and fungi in the area of breakage was recorded. From 1976 until August 1982, woodcutters cut two treated and two untreated trees; therefore, they were deleted from the original 30 pairs, leaving 28 pairs for comparison.

From August 1982 until May 1984, the trees at both sites were not revisited. When checked in May 1984, most of the remaining standing trees had been cut. Thus, the results are based on the data through 1982, although it appears that few of these trees would have fallen between 1982 and 1984.

To identify the insects contributing to tree fall, bolts from trees infested in different years were placed in rearing. In September, 1978, two trees infested in each of 1974, 1975, 1976, 1977 and 1978 were felled in the vicinity of the Log Cabin trees east of Red Feather Lakes. Three 1-foot bolts were removed from each tree at 0-1 foot, 5-6 feet and 10-11 feet above ground. The bolts were placed in cages in a greenhouse, and adults were collected as they emerged and later identified.

Each year after infestation, the percentages of fallen treated and untreated trees in the insecticide test were examined, and a chi-square test was performed, $\alpha = 0.05$.

After 10 years, the mean diameter of fallen trees for each location was compared against the mean respective diameter of standing trees to determine if size influenced falling, $\alpha = 0.05$.

Results and Discussion

No trees fell during the first 2 years after infestation. Trees began falling during the third and fourth years (fig. 1A). At the Red Feather Lakes locations, 3% to 4% of the trees fell each year during the 4 years after trees started falling (years 4-7). Thereafter, the rate increased substantially, so that the majority of the trees fell between 7 and 10 years after infestation. The rate of falling for untreated trees at Arthur's Rock averaged about 17% per year for the first 4 years after trees began falling. Thus, the rate of falling differed significantly between the two areas once trees began falling.

The initial rate of fall differed slightly from that found by Keen (1955). Keen observed 5% of 10% of the trees falling within 3 years, whereas 11% of the untreated trees at Arthur's Rock and no trees at Red Feather Lakes fell within 3 years in this study. Keen also found the rate of falling increased substantially between the 5th and 15th years, while the trees in this study started falling more frequently between the 7th and 10th years at Red Feather Lakes and the 4th and 6th years at Arthur's Rock. In Keen's (1955) and these studies with ponderosa pine, the rate of falling was much greater than the annual rate of 1.5% per year for beetle-killed spruce, *Picea engelmannii* Parry, as found by Schmid and Hinds (1974).

The different rates of fall at Arthur's Rock and the Red Feather Lakes locations suggests some factor(s) caused more rapid deterioration and fall on the former site. However, chronologically, most of the trees fell the same years (fig. 1B), which implies that the same factor affected both locations. In 1974 and 1976, winds exceeded 75 mph; but few trees fell. However, in the first 4 months of 1982, winds exceeded 75 mph on several occasions, toppling numerous beetle-killed trees. Thus, it appears that trees deteriorate slowly for 3–5 years, during which time they are relatively sturdy and not unusually susceptible to windthrow. Once the trees deteriorate more, their toppling primarily depends on the occurrence of strong winds. If winds exceed 75 mph, up to 50% of the trees may fall during one storm. If winds are of lesser velocities, lesser percentages will fall, with the more susceptible trees falling first.

The rate of falling of the insecticide-treated trees was significantly less during the first and second years trees fell (years 3-4) than it was for untreated trees; but thereafter, both sets of trees fell at the same rate. The insecticide prevented the more immediate secondary insects, such as cerambycids and other scolytids, from infesting the tree during the first 3 years following infestation. Thereafter, its effectiveness apparently greatly decreased, because secondary insects, such as carpenter ants, were able to enter the trees.

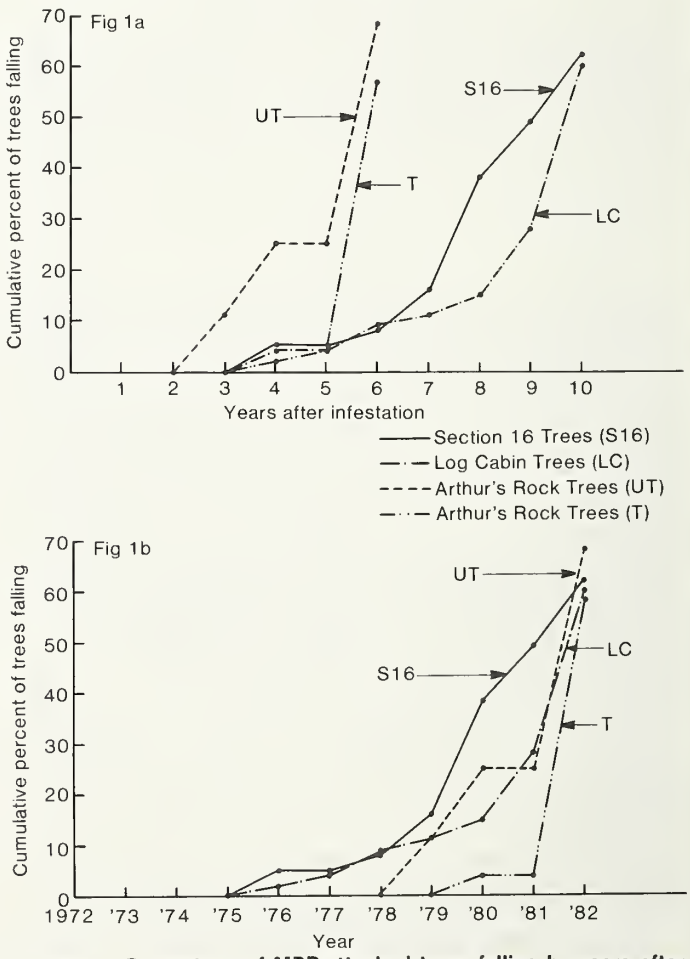

Figure 1.—Percentage of MPB-attacked trees falling by years after infestation (1A) and year (1B).

Insects commonly emerging from the reared bolts were cerambycids (*Acanthocinus obliquus* LeConte, *Asemum striatum* [Linnaeus], *Stenocorus lineatum* [Oliver]), scolytids (*Gnathotrichus denticulatus* Blackman, *Hylurgops subcostulatus* [Mannerheim], *Ips knausi* Swaine, *Pityokteines ornatus* [Swaine]) and other associated beetles. Those species most influencing tree fall were probably *A. obliquus*, *A. striatum*, *G. denticulatus* and *P. ornatus*, because they create galleries in the wood, whereas the other species inhabit the inner bark.

The fungus causing decay in the basal portions of the stem was *Fomitopsis pinicola* (Swartz ex. Fr.) Karst.[3]

Two-thirds of the fallen trees at Section 16 and 50% of the trees at Log Cabin broke off at ground level. All of the trees at Section 16 and 85% of the trees at Log Cabin broke off at or below 2 feet above ground. These results differ substantially from unpublished observations in the Black Hills of South Dakota, where about 25% broke off at ground level and the majority broke between 15 and 20 feet above ground.

All trees at the Red Feather Lakes locations and about 90% of the trees at Arthur's Rock fell towards the east. Those trees falling towards the west either were leaning strongly in that direction while standing or were pushed in that direction by adjacent toppling trees. This data strongly implies wind is a primary factor influencing direction of fall. Keen (1955) claimed the occurrence of windstorms was a major factor influencing rate of fall. In this case, it appears that once trees are conditioned to fall, hurricane velocity winds which commonly develop from a westerly direction in the Front Range influence both the rate of and the direction of fall.

[3]*Personal communication-T.E. Hinds, RM Station.*

Tree diameter was not significantly different between fallen and standing trees at either location.

	Red Feather Lakes	*Arthur's Rock*
	$\bar{x} \pm$ S.D.	
Standing	11.0 ± 3.2	10.1 ± 4.3
Fallen	11.7 ± 3.6	10.0 ± 3.5

A greater number of tagged trees would probably provide better information on the influence of tree diameter.

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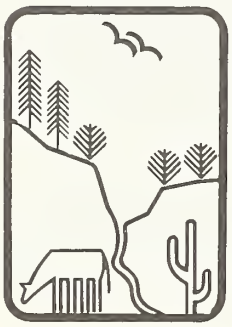

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